Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Swimming Efficiently: An Analytical Study of Optimal Swimming in Fish A. JOSH WIENS, ANETTE HOSOI, Massachusetts Institute of Technology — The Strouhal Number (St), is widely considered to be the defining parameter for efficient undulatory swimming. Biological studies have shown that fish species across a broad range of shapes and sizes adhere to a narrow St range ($0.2 < St < 0.4$). Despite its significance, St alone provides an incomplete description of the kinematics and geometry of a swimming fish. The dimensionless speed and amplitude of the body wave, along with the size and shape of the body can also play a significant role in swimming performance. We apply Lighthill's elongated body theory to construct a simple but powerful reduction of the steady-swimming problem. Through this reduction, the energetic efficiency of a swimming fish can be directly expressed as an analytical function of body geometry and kinematics. In this reduced form, the interplay between the parameters of the system, and their collective role in determining the performance of the swimmer can be readily observed and understood. In particular, the reduced model is applied to understand how wave amplitude, wave speed, and St must relate for optimal swimming efficiency. Following this, we then explore how these relationships are altered by geometric factors such as tail size and compliance.

Alexander Wiens
Massachusetts Institute of Technology

Date submitted: 30 Jul 2014 Electronic form version 1.4